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# Evaluating the Contribution of GDP, Technological Advancements, and Renewable Energy Consumption in Carbon Emissions to the Attainment of Sustainable Development Goals: Insights from China

Waseem Hassan [*] Naveed Hussain [†] Shahzeb Hussain [‡]

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**Abstract:** *The proposed research examines how renewable energy consumption, GDP, and carbon emission technology affect China's sustainable development goals. The writer utilized OECD and World Bank databases to gather 2000–2020 secondary data. The inferential and descriptive technique assesses the Chinese understanding of how renewable energy consumption, GDP, and technological advancements concern sustainable development goals. In this research effort, the final acquired data were input into SPSS and evaluated to obtain statistical conclusions. SPSS Statistical software has been utilized to calculate the empirical study's results utilizing descriptive statistics, regression analysis, factor analysis, and one-way ANOVA. The study's methodology describes the analysis criteria and recommendations to test hypotheses and achieve goals. This research may stimulate renewable energy consumption, GDP, and technological advancements to mitigate carbon emissions and achieve China's Sustainable Development Goals. Implementing renewable energy initiatives and encouraging constructive economic growth can do this.*

**Key Words:** Carbon Emissions, China, GDP, Renewable Energy Consumption, SDGs, Sustainable Development Goals, Technological Advancements

## Introduction

This research's primary goal is to study how carbon emissions, energy from renewable sources, GDP, and technological advancements contribute significantly to attaining China's sustainable development goals. For this purpose, we acclimatize the methodology for assessing the most crucial contribution of these eras to attain sustainable development goals, thereby accelerating China's economic growth. Based on the significance and importance of the conclusions, others can infer that renewable energy substantially impacts achieving the Sustainable Development Goals (SDGs). Due to worldwide energy resource replenishment, deterioration of the natural environment, and global warming, repercussions of climatic transformation have become undeniable in recent years, and renewable environmental sustainability has become a central concern for numerous nations (Mardani et al., 2019).

The origin of sustainable development can be traced back to the 1980s when the United Nations acknowledged the importance of environmental protection in development plans. Sustainable development has been increasingly defined as encouraging adaptive abilities and offering opportunities to maintain or enhance appropriate economic, social, and natural environments for present and future generations (Bali Swain & Yang-Wallentin, 2020). The United Nations (UN) has developed sustainable development goals to preserve the foreseeable time of the globe. The UN is convincing and supporting both to make remarkable

[*] Ph.D., School of Economics and Management, China University of Geosciences, Wuhan, China.
[†] MSc., School of Accountancy and Finance, The University of Lahore, Lahore, Punjab, Pakistan.
[‡] BS-Commerce, Department of Management Sciences, Abbottabad University of Science and Technology, Abbottabad, KP, Pakistan.

Corresponding Author: Ph.D., School of Economics and Management, China University of Geosciences, Wuhan, China. Email: 2202290009@cug.edu.cn)

efforts to achieve the purposes mentioned earlier to get success to their respective countries. The SDGs comprise seventeen goals and 169 targets that the participant countries of the UN are opting to apply to constitute or lead their development objectives and Legislative efforts over the next 15 years (roughly until 2030) to change the world as a whole (Raihan et al., 2022);(Q.-Q. Liu et al., 2015); (Rashid et al., 2018); (Weber, 2017). The seventeen goals are grounded on the (MDGs) and include, among other priorities, lowering poverty rates, sanitation and clean water, renewable energy, daily life at or below land, life on land, strengthened health, high-quality learning and employment, justice and peace, conservation of resources, and wealth disparity (Usman & Tasmin, 2016). The USA has introduced the SDGs platform, a structure designed to assist countries and contributors in eradicating inequality. In the current scenario, (Opoku et al., 2019) studied the SDGs to alleviate impoverished circumstances (Institutionalized lending). Ghana was the site of the examination. Interviews were utilized to collect the 48-person sample. According to the outcome of the investigation, eradicating economic inequality will result from accomplishing SDGs.

Furthermore, (Crespo Cuaresma et al., 2018) analyzed the relationship between attaining SDGs and worldwide impoverishment (including institutional government loans). The investigation's sampling of data included 188 countries and regions. The examination demonstrated that the program instituted by the United Nations aids the global strive to eliminate hunger. Therefore, nations must pay more attention to conquering SDGs. Likewise, (Roy et al., 2018) SDGs and inequality were prioritized. The results demonstrate that sustainable development goals alleviate impoverishment and lessen inequalities.

Renewable energy is at the core of many of the world's most significant obstacles and opportunities. Energy access is vital for employment safety, environmental preservation, and food production (W. Liu et al., 2020).

Energy has grown into one of the fundamental requirements of the universe as a whole. All facets of life for humans are related to energy or dependent on it. (Büyüközkan et al., 2018) Worldwide energy consumption is rising swiftly, but not production. Nations consume coal to meet their energy demands. This traditional energy source threatens nature. Nations are encouraged to utilize renewable energy by the UN. In this context, (Martí-Ballester, 2022) emphasized renewable energy sources (Whether they are managed by governmental entities or private sector financial organizations, including those according to traditional or Islamic principles.) and sustainable development goals. The investigation used a sample of 1074 investments—the data range from 2006 until 2019. The research observed that financial institutions push enterprises to boost their societal and ecological efficiency. Thus, renewable energy mutual funds' investments yield actual returns. This demonstrates the efficacy of economic mechanisms to advance the financial services industry's sustainability goals and assist the change to a sustainable factual financial system, which affects policy. (Kwakwa et al., 2021) Probed the energy-related SDGs (produced by projects offered by mutually conventional and Islamic finance)—in Africa, where the study was conducted place. The study surveyed 31 South African nations. Included in the sample are the years 2000 through 2015. The investigation observed that while wealth and prosperity, direct investments from abroad, the system of politics, and job opportunities have beneficial impacts on obtaining renewable energy, the rate of inflation has adverse consequences. Therefore, achieving sustainable development goals concerning energy will lead to both ecological stabilization and regional economic growth. As per the International Energy Agency (IEA), 90% of the energy used for sustaining the world's economies is expected to be sourced from renewable energy sources by the year 2050 (Wang et al., 2021); (Mao et al., 2020); (H. Li et al., 2020).

In 40 years of development and innovation, China has achieved impressive economic development and improved economic performance, boosting the need for resources to support residents' livelihoods and industrialization. (Ma et al., 2021) (Guo et al., 2022). With the enormous combustion of climate-altering gases, especially carbon dioxide ($CO_2$), the standard of life of people worldwide and the economic development of every country are threatened (Murshed et al., 2021). The International Energy Agency's (IEA) most recent statistics reveal worldwide emissions of carbon dioxide ($CO_2$) will surpass 36.3 billion tons in the year 2021, a spike of six per cent in comparison to the year 2020 and a historic high as a result of catastrophic weather and increasing demand for energy. As the world's fastest developing nation, China's total green building production surpassed 6.99 billion tons in 2007, eclipsing the United States for the first while and placing first globally. China's total carbon dioxide

($CO_2$) emissions will make up for 1/3rd of the globe's carbon by 2021, based on the most recent data from Carbon Briefing. In the (EPI) Environmental Performance Index: 2016 Report, China defences 160th in the (EPI) Environmental Performance Index, apart from forty points from the year 2018, building it the "hardest impact" with regards to pollutant spillover, mirroring the immense strain on the natural atmosphere led by China's accelerated growth in the economy. In light of today's intensifying rise of globalization, the Chinese government has to immediately employ appropriate legislative measures to address the difficulties of "adapting framework," advancing transition," "averting contamination," and "lowering toxins." China's government has enacted several sustainability regulations, laws, and strategies to attain green and sustainable development goals (Arimura & Sugino, 2007).

In this regard, the research evaluates the Chinese government's assessment of renewable energy's contribution to sustainable economic development goals. The study uses 2000–2020 yearly data to investigate ecological sustainability across several Chinese areas. The research findings can assist Chinese governments in attaining environmental sovereignty by enhancing renewable energy, sustainability, and competency. This work's highlights are based on a literature synthesis and theoretical analysis. Initially, we investigate that renewable energy resources are amenable to reducing carbon emissions and analyze the fact that Energy Resources can attain sustainable development goals using Renewable Energy Technologies from the statistical analysis viewpoint—secondly, the degree to which renewable energy fosters environmentally friendly growth. Thirdly, considering the geographical variability of energy resources., the study investigates whether there are also geographical inequalities in the consequences of green energy technologies on reducing carbon dioxide under the influence of Energy Resources. Lastly, the understanding that the more robust Resources for Energy boosts the region's adoption of renewable energy technologies. Outlining these time frames can encourage global collaboration on Carbon Emission reduction innovations and preservation of the environment prospects while additionally providing a fundamental framework for attaining the international carbon equality aim.

The first section introduces the research and its significance. The second half covers the SDGs and China's renewable energy boom. The third section discusses renewable energy development methods, including data collecting. The fourth section evaluates inferential and descriptive approaches. The study's findings and suggestions are in the fifth part. The last part has references.

## Review of Literature

The attention of the research study is to emphasize the contribution and significance of renewable energies, achieve the SDGs aims, and support the demands of the worldwide community.

Despite the significance of renewable energy-based mutual fund investments in the execution of local economic initiatives, such as the European Union Renewed Sustainable Finance Strategy, in attaining renewable energy (SDG7) goals, literary finance has ignored the specific impact going on renewable energy, ecological, and social advancements done by investment assortment corporations. Mutual funds investing in renewable energy sources can tap into their right to vote and managerial expertise to incorporate sustainable energy and environmentally conscious initiatives into the companies' fundamental business strategies (Oh et al., 2011).

Nowadays, almost 150 years after the discovery of the first photovoltaic device, the use of solar energy continues to grow at an even faster pace than other forms of renewable energy (+24% annually, according to the IRENA report for 2019) due to improvements in technology that enable the development of ever-more-efficient solar energy plants. The sun will keep providing renewable energy by shining vividly in the sky (Spiru, 2023). Like Hydropower and photovoltaic power stations, biomass-based power plants can be categorized as renewable energy resources (Yahya et al., 2021).

To achieve its goals for 2030 for renewable energy's share of ultimate overweight depletion of energy and carbon independence of the Energy sector by 2050, the European Union must bring together as many sources that are renewable as possible (such as Hydropower, wind power, solar power, and the quantity from biomass) into an extensive energy system. With global warming causing severe risks to human civilization, several nations have attached the concept of "carbon neutrality" to a national approach and proposed a carbon-neutral destiny. Consequently, environmental contamination creates an imminent danger to the natural atmosphere in the context of multiple nations' internationalization and economic growth. China confronts the same issue of worsening the quality of the environment (Hao, 2022). China, as a responsible global position of power, is adopting proactive and successful moves to deal with the problem of environmental degradation. The government of China proclaimed at the 75th UN General Assembly that it will aim to reach zero greenhouse gases by 2060 and reach its highest greenhouse gas emission levels by 2030. China's steep rise in greenhouse gas emissions is primarily attributable to the country's environmentally harmful energy sources infrastructure. (Y. Li et al., 2021). China's current Renewable Energies Policies (REP) mainly tackle global warming and expedite the renewable energy revolution. China's newest national policy on energy, "the 14th 5-Year Plan," announced by the (NDRC), has as its primary objective to meet the demand for approximately 20% renewable energy sources by 2025. By the year 2025, the total energy produced from renewable sources demand will surpass 1 billion tons of conventional carbon dioxide (National Development and Reform Committee (NDRC), 2021). China continues to have some way towards its goal concerning its usage of renewable energy compared to other nations and territories. Most nations have comparable objectives to China; for instance, a "New Energy Basic Plan" devised by the government of Japan to raise the rate of renewable energy sources to 22–24% by the year 2030 (Energy Transition, 2023).

China has made tremendous strides in renewable energy, but things still need improvement. Despite China's enormous successes in sustainable energy, the data mentioned earlier indicate that China keeps going under worldwide pressure concerning renewable energy growth and that its circumstances remain critical. For its two-fold greenhouse gas aims, China must boost its massive, high-proportion, and high-quality renewable energy policy goals (Qiufang Fan, 2022). In the Report of Xi to the 19th (NCCP) National Congress of the Communist Party of China, the concepts of "green" and "ecology" appear multiple times. The Chinese government's ambition of revolutionary advances and developments in energy and preservation of the environment has evolved into a crucial tool in pursuing this aim. Renewable energy is a potential benefit because it strengthens living, economic growth, and the planet's health (Paraschiv & Paraschiv, 2020). Considering sources of renewable energy, the aim was established with these essential components in consideration: making a contribution to the European goal in compliance with the stipulations of the accountability legislation. Maximizing the utilization of renewable energy resources is an important objective, particularly in the electrical power industry, where the availability of resources with greater growth potential, such as solar and wind power, fluctuates. Similarly, biomass utilization is constrained by sustainability goals that must be considered in the thermodynamic power industries. The National Integrated Energy and Climate Plan (NIECP) for the year 2030 is an integral tool that footprints the start of a significant shift in both the energy and ecological policies of the nation, with the following goals in mind: climatic warming prevention, boosting energy resources conservation and reliability of energy, along with the growth of the nation's internal energy marketplace, innovation, research, and rivalry (Paraschiv et al., 2020).

This shift is intended to be implemented alongside an innovative energy strategy that assures the entire sustainability of the country's environment, society, and economy (Tu et al., 2021); (Gao et al., 2021). Sources of clean energy (photovoltaic power, hydro energy, wind energy, marine energy, geological energy, carbon dioxide, and biofuels or biomass are non-fossil alternative fuels that assist in reducing emissions of greenhouse gases, expand the source of energy and minimize dependability (Do et al., 2021); (Boopathi et al., 2021); (Nandimandalam et al., 2022); (Norvaiša et al., 2021).

To address this absence of facts, this research evaluates how renewable energy contributes to attaining sustainable development goals (SDGs) by assessing renewable energy, the natural world, and the socially accountable efficiency of portfolio corporations on a global scale. To address this research, the present research studies the contribution of renewable energy sources to attaining sustainable development goals (SDGs) through evaluating environmentally sustainable energy practices, ecological considerations, and social responsibility within global portfolio firms.

## Methodology

The current research study conveys a statistical assessment of the contribution served by renewable energy consumption, growth in the economy, and technological advancements in carbon emissions reduction, with a focus on China's efforts to achieve sustainable development goals (SDGs). The historical data from 2000 to 2020 is analyzed through the SPSS Statistical software. Descriptive statistics, regression analysis, factor analysis, and one-way ANOVA are used to present empirical results.

## Data Collection and Method

This research study presents a statistical analysis of the contribution of economic growth, technological Advancements, and renewable energy consumption in carbon emissions as sustainable development goals (SDGs) pursued by China. The research study made use of historical data covering from 2000 to 2020. The data has been analyzed through the SPSS Statistical application, and various statistical techniques, including descriptive statistics, regression analysis, factor analysis, and one-way ANOVA, have been used to retrieve empirical results.

**Table 1**

*Logarithmic Variables, Units, and Data Sources*

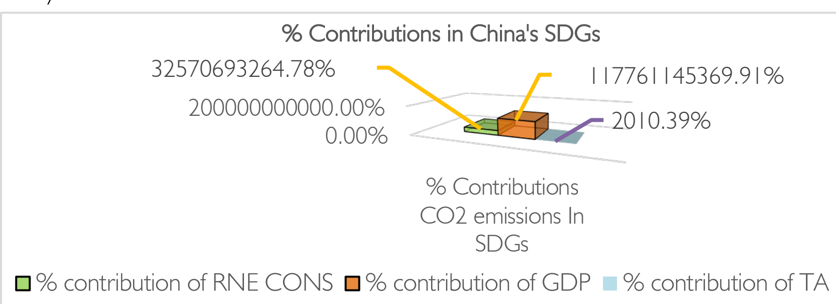
| Variable Type | Variables Symbol | Description | Logarithmic forms | Units | Sources |
|---|---|---|---|---|---|
| Dependent Variable | CO2 | CO2 emissions | LCO2 | Kilotons (kt) | World Development Indicators |
| Independent Variable | RE CONS | Renewable Energy Consumption | LRE | Renewable energy consumption (% of total final energy consumption) | World Development Indicators |
| Independent Variable | GDP | Economic Growth | LGDP | GDP (constant 2015 US$) | World Development Indicators |
| Independent Variable | TA | Technology Advancements | LTA | Real interest rate | World Development Indicators |

This research study examines the relationship between carbon dioxide emissions and several independent variables, including economic growth, technological advancements, and renewable energy consumption. The present investigation quantifies carbon dioxide emissions in kilotons (kt), utilizing Periodic data obtained from the World Development Indicator (WDI) dataset, as provided by the (World Bank, 2023). The Gross Domestic Product (GDP), expressed in fixed local money definitions, has been commonly utilized as an interim measure for evaluating financial progress. The temporal information about China's GDP is obtained from the World Development Indicator (WDI) dataset provided by the (World Bank, 2023). Technological Advancements have been utilized, and the Periodic data have been acquired from the World Development Indicator (WDI) dataset, as reported by the (World Bank, 2023). Moreover, the percentage of renewable energy consumption concerning whole energy consumption and the yearly statistics about renewable energy are sourced from the World Development Indicator (WDI) dataset, as provided by the (World Bank, 2023).

The variables also endure a logarithmic transformation to verify the data has a normal circulation. Table 1 presents the variables and their logarithmic demonstrations, measurement components, and data sources.

**Figure 1**

Effectively Portrays the Idea's Structure



The analysis of the contribution of CO2 emissions, RNE CONS, GDP, and TA to achieving economic demands and sustainable development objectives is outlined in China with an optimistic mission. Figure 01 depicts the contribution to Sustainable Development Goals (SDGs) through numerous components, including 91% GDP, 78% Renewable energy consumption, 39% Technological achievements, and 22% Carbon emissions. This broad energy policy strives to lower the country's dependence on energy sources such as fossil fuels by encouraging sustainable development goals, decreasing carbon emissions, and facilitating the advancement of technologies. The depicted figure highlights China's commitment to a more environmentally friendly future and its leading position in the global transition towards more sustainable and ecologically conscious energy sources.

## Statistical Research Model of the Study

This research uses an approach to theory that analyses a hypothesis within the context of a Cobb-Douglas production function (Cobb & Douglas, 1928). The subject matter of the current study is grounded on the theoretical principles of production economics, aiming to assess the impact of economic growth, technological advancements, and renewable energy consumption on China's carbon dioxide (CO2) emissions. The cumulative production function can be signified by employing a regular Cobb-Douglas production function under the assumption of a constant rate of returns.

$Y_t = f\ (K_t\ , L_t)$ ________________ (Equation: 01)

Where,

$Y_t$ = The Gross Domestic Product (GDP) for the period t.

$K_t$ = The amount of capital at the time t.

$L_t$ = The concept of labour during the time t.

In theoretical terms, there occurs a connotation between CO2 emissions and GDP. Given the prevailing assumption that emissions of CO2 are primarily generated as a result of economic activity. Therefore, it can be proven that the carbon dioxide (CO2) emission operation may be expressed in the form that follows:

$CO2_t = f\ (GDP_t)$______________ (Equation: 02)

Where,

$CO2_t$ = Carbon emissions at the Time t.

In addition, a correlation exists between accelerated economic development and heightened energy utilization throughout the production phase. However, integrating renewable energy resources into the final energy consumption is crucial in attaining environmental sustainability objectives, primarily by diminishing carbon emissions from energy resources in line with fossil fuels. The research aims to evaluate the influence of renewable energy utilization on carbon emissions. Therefore, it is appropriate to represent Equation 02 in the following structure:

$CO2_t = f\ (GDP_t\ ; RE\ CONS_t)$____ (Equation: 03)

Where,

$RE\ CONS_t$ = Renewable energy consumption at the Time t.

Reflecting upon the discourse presented in the introductory and literature review parts, it is evident that technological advancement can influence CO2 emissions. Consequently, the current study incorporates technological advancement as a crucial model component. Also, the study conducted by (Sohag et al., 2015) demonstrated that technological advancement is pivotal in boosting economic development through enhancing dynamic efficiency and promoting energy consumption reductions. The primary objective of this investigation is to inspect the potential effect of technological advancement on reducing carbon dioxide (CO2) emissions.

This research employed a set of economic gatherings to examine the relationship between economic growth, technological advancements, carbon emissions, and renewable energy consumption.

$CO2_t = f\ (GDP_t;\ RE\ CONS_t;\ TA_t)$ (Equation: 04)

Where,

$TA_t$ = Technological Advancements (sum of patent applications) at the Time t.

Equation (05) represents the pragmatic model in the structure of an econometric model:

$CO2_t = \tau_0 + \tau_1 GDP_t + \tau_2 RE\ CONS_t + \tau_3 TA_t$ _____________ (Equation: 05)

Equation 05 is subsequently elaborated upon and transformed into an econometric model, which is presented in the below format:

$CO2_t = \tau_0 + \tau_1 GDP_t + \tau_2 RE\ CONS_t + \tau_3 TA_t + \varepsilon_t$_________ (Equation: 06)

Where,

The symbols $\tau_0$ and $\varepsilon_t$ Represent the intercept and error terms accordingly. Furthermore, the factors $\tau_1$, $\tau_2$ and $\tau_3$ denote the coefficients.

Finally, Equation 07 represents the logarithmic structure of Equation 06.

$$LCO2_t = \tau_0 + \tau_1 LGDP_t + \tau_2 LRE\ CONS_t + \tau_3 LTA_t + \varepsilon_t \quad \text{\_\_\_\_\_\_\_\_ (Equation: 07)}$$

Where,

$LCO2_t$ = logarithmic structure of carbon emissions at the Time t.

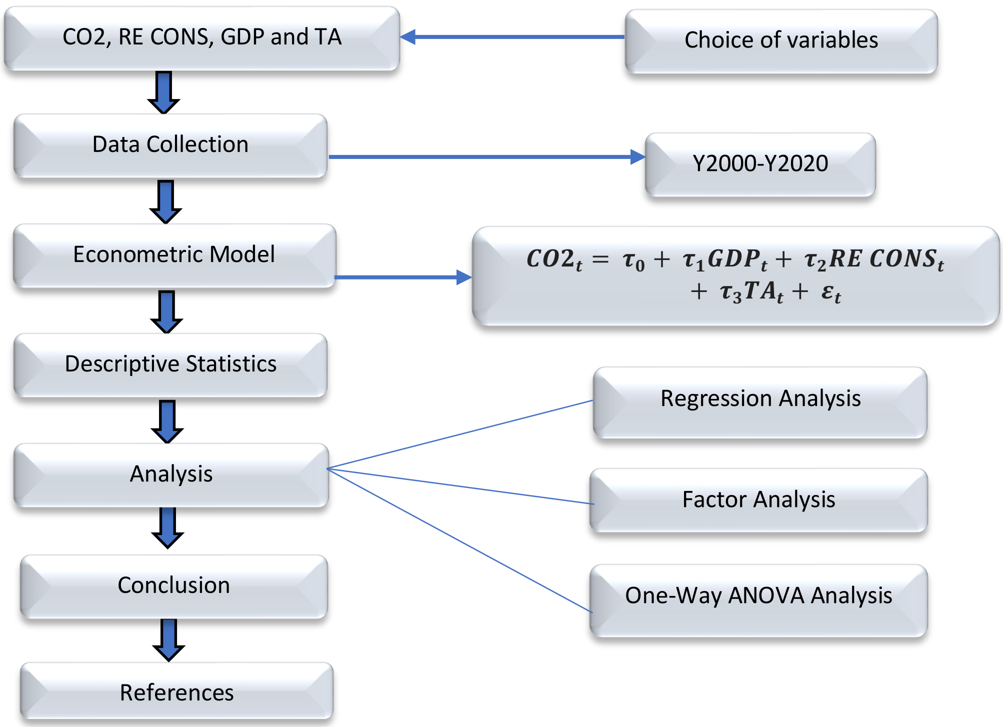
$LGDP_t$ = logarithmic structure of Economic Growth at the Time t.

$LRE\ CONS_t$ = logarithmic structure of renewable energy consumption at the Time t.

$LTA_t$ = logarithmic structure of Technological Advancements (sum of patent applications) at the Time t.

## Structural Research Model of the Study

The fundamental research study frame model is as follows:




## Empirical Results and Discussion

After assembling the necessary data, appropriate tools and methodologies were employed for categorization and analysis. The research was evaluated employing several statistical techniques, including descriptive statistics, regression analysis, factor analysis, and One-Way ANOVA. The analysis procedures were conducted using the Statistical Package for Social Science (SPSS) software to accomplish this objective.

## Results

### Table 2

*Descriptive Statistics*

| | N | Minimum | Maximum | Mean | Std. Deviation | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| SDGs Attainment | 21 | 6.93E+11 | 3.65E+12 | 1.9931E+12 | 9.84621E+11 | 9.695E+23 | .286 | -1.255 |

| | N | Minimum | Maximum | Mean | Std. Deviation | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| CO2 EMISSIONS | 21 | 3346525.80 | 10944686.20 | 7798370.2762 | 2597242.17710 | 6.746E+12 | -.507 | -1.221 |
| RNE CONS | 21 | 11.34 | 29.63 | 16.4010 | 5.85814 | 34.318 | 1.352 | .526 |
| GDP | 21 | 2.77E+12 | 1.46E+13 | 7.9724E+12 | 3.93848E+12 | 1.551E+25 | .286 | -1.255 |
| TA | 21 | 51906.00 | 1542002.00 | 630961.0476 | 542796.03238 | 2.946E+11 | .570 | -1.329 |
| Valid N (listwise) | 21 | | | | | | | |

*Authors' calculations*

The results of the table Present Value of the SDGs attainment (dependent variable) and CO2 emissions, RNE CONS, GDP, and TA (Independent Variables) are as follows:

Table 02, however, shows that the participant's SDGs attainment mean is M= 1.9931E+12, with standard deviations of SD= 9.84621E+11 for SDGs attainment and SD= 2597242.17710, 5.85814, 3.93848E+12 and 542796.03238 for independent variables respectively. The Dependent Variable Mean M is 1.9931E+12, whereas the Mean M for Independent Variables is 7798370.2762, 16.4010, 7.9724E+12, and 630961.0476, respectively. At last, the resultant data dispersion conveys a slight right skew, highlighted by an asymmetrical value of 0.286 for SDG attainment. RNE CONS is 1.352, GDP is 0.286, and TA is 0.570, While an asymmetrical value of -0.507 for CO2 emissions expresses a slight left skew. The SDGs Attainment, CO2 Emissions, GDP, and TA matrices reflect Platykurtic qualities, with tail heaviness measures of -1.255, -1.221, -1.255, and -1.329, respectively. The measurement of the tails' thickness in the distributions of RNE CONS is 0.526, indicating a mesokurtic quality.

## Regression Analysis

### Table 3

*Correlations*

| | | CO2 EMISSIONS | RNE CONS | GDP | TA |
|---|---|---|---|---|---|
| CO2 EMISSIONS | Pearson Correlation | 1 | -.886** | .945** | .880** |
| | Sig. (1-tailed) | | .000 | .000 | .000 |
| RNE CONS | Pearson Correlation | -.886** | 1 | -.702** | -.595** |
| | Sig. (1-tailed) | .000 | | .000 | .002 |
| GDP | Pearson Correlation | .945** | -.702** | 1 | .980** |
| | Sig. (1-tailed) | .000 | .000 | | .000 |
| TA | Pearson Correlation | .880** | -.595** | .980** | 1 |
| | Sig. (1-tailed) | .000 | .002 | .000 | |
| Listwise N=21 | | | | | |

***. Correlation is significant at the 0.01 level (1-tailed).*

The Pearson correlation approach is widely employed for quantifying the relationship between quantitative variables. It yields a value ranging from -1 to 1, where 1 signifies a complete positive correlation, -1 indicates an absolute negative correlation, and 0 represents the absence of correlation.

Table 03 highlights the correlation analysis results, Which examined linear correlations among the variables. The findings indicate a significant correlation among all the variables. A robust and positive association exists among CO2 emissions, GDP, and TA, meaning that a rise in the value of one variable is typically accompanied by an increase in the value of the other variables, and conversely. However, the analysis of RNE CONS exhibits an adverse correlation with all the other variables, showing that an upsurge in renewable energy depletion is connected with shrinkage in the values of the other variables and vice versa.

Table 4

*Model Summary* [c]

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change | Durbin-Watson |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .945[a] | .893 | .887 | 872018.69355 | .893 | 158.420 | 1 | 19 | .000 | |
| 2 | .995[b] | .990 | .989 | 273141.82542 | .097 | 175.655 | 1 | 18 | .000 | .488 |

*a. Predictors: (Constant), GDP, b. Predictors: (Constant), GDP, RNE CONS, c. Dependent Variable: CO2 EMISSIONS*

The Durbin-Watson Model is a statistical approach applied to assess autocorrelation, often referred to as serial correlation, within the residuals of a regression analysis. Autocorrelation refers to the degree of consistency throughout consecutive time intervals. The potential outcome of this scenario is the underestimation of the standard error, leading to a misleading perception of the significance of predictors that may not be significant.

The Durbin-Watson test yields a test statistic that ranges from 0 to 4, with values of 2 indicating the absence of autocorrelation.

Positive autocorrelation is observed when the values of a time series are positively correlated with their own lagged values. The range of positive autocorrelation is typically between 0 and 2. Time series data is commonly observed in several fields.

Negative autocorrelation occurs between a lag of greater than 2 to 4. However, it is less frequently observed in time series data.

According to the notion of the Durbin-Watson (DW) test statistic, the regression analysis technique implemented in my study yielded a value of 0.488, which indicates a positive correlation with the DW test, as seen in Table 04. Furthermore, the DW Test confirms a statistically significant value of 0.000 for the predictor, which aligns with the aforementioned standard error results, calculated as 273141.82542.

Table 5

*Coefficients*[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 2830441.567 | 438178.533 | | 6.460 | .000 | 1913323.359 | 3747559.776 |
| | GDP | 6.231E-7 | .000 | .945 | 12.587 | .000 | .000 | .000 |
| 2 | (Constant) | 7630588.677 | 387313.683 | | 19.701 | .000 | 6816872.825 | 8444304.530 |
| | GDP | 4.204E-7 | .000 | .637 | 19.297 | .000 | .000 | .000 |
| | RNE CONS | -194108.869 | 14645.867 | -.438 | -13.253 | .000 | -224878.693 | -163339.044 |

*a. Dependent Variable: CO2 EMISSIONS*

The predictor variables are shown in Table 05, specifically the constant term and the GDP variable. The vertical position of the regression line at the point where it intersects the Y-axis is denoted by the constant term, often known as the Y-intercept.

Unstandardized coefficients, characterized by a B value of 2830441.567, predict a dependent factor based on the independent factor.

Standard errors with coefficients testing with a value of 438178.533, representing that the parameter is suggestively diverse from 0, are obtained by dividing the B by the standard error, giving a t-value of 6.460.

The constant in this instance considerably strayed from 0 at the 0.05 alpha level, Sig. and t. However, a significant intercept is rarely exciting.

Because of its p-value of 0.000, which is less than 0.05, the coefficient for innovative strategy (-194108.869) is statistically significant from 0 using an alpha of 0.05.

## Table 6

*Coefficients Correlations [a]*

| Model | | | GDP | RNE CONS |
|---|---|---|---|---|
| 1 | Correlations | GDP | 1.000 | |
| | Covariances | GDP | 2.451E-15 | |
| 2 | Correlations | GDP | 1.000 | .702 |
| | | RNE CONS | .702 | 1.000 |
| | Covariances | GDP | 4.746E-16 | .000 |
| | | RNE CONS | .000 | 214501420.423 |

*a. Dependent Variable: CO2 EMISSIONS*

Table 06 shows that the variables GDP and RNE CONS have a perfect positive correlation coefficient relationship, with a correlation value of 1. The GDP and RNE CONS contributed strongly in CO2 Emissions to attaining the SDGs by China's government, and there would be a positive correlation, indicating that GDP and RNE CONS would likewise advance the SDGs Goals by China.

## Factor Analysis

## Table 7

*Correlation Matrix*

| | | RNE CONS | GDP | TA | CO2 EMISSIONS |
|---|---|---|---|---|---|
| Correlation | RNE CONS | 1.000 | -.702 | -.595 | -.886 |
| | GDP | -.702 | 1.000 | .980 | .945 |
| | TA | -.595 | .980 | 1.000 | .880 |
| | CO2 EMISSIONS | -.886 | .945 | .880 | 1.000 |
| Sig. (1-tailed) | RNE CONS | | .000 | .002 | .000 |
| | GDP | .000 | | .000 | .000 |
| | TA | .002 | .000 | | .000 |
| | CO2 EMISSIONS | .000 | .000 | .000 | |

The table's insights the subsequent analysis clarify the correlation between carbon emissions and GDP, TA, and RNE CONS.

Table 07 presents the correlation coefficients between the variables RNE CONS, GDP, TA, and CO2 Emissions. The correlation coefficient for RNE CONS is 1.000, indicating a perfect positive correlation. Additionally, the correlation coefficients for GDP, TA, and CO2 Emissions are -0.702, -0.595, and -0.886, respectively, showing strong negative correlations between these variables. In addition, the RNE CONS (Renewable Energy Consumption) significantly reduced CO2 emissions. The statistical analysis indicated a coefficient of 1.000 for the RNE CONS, suggesting a strong positive relationship. Conversely, the correlation coefficients for GDP, TA (Technological Advancements), and CO2 emissions are respectively -0.702, -0.595, and -0.886. The statistical significance values (one-tailed) for RNE CONS, GDP, TA, and carbon emissions are 0.000, 0.000, 0.002, and 0.000.

## Table 8

*KMO and Bartlett's Test*

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .633 |
|---|---|---|
| Bartlett's Test of Sphericity | Approx. Chi-Square | 162.863 |
| | df | 6 |
| | Sig. | .000 |

The explanations below summarize the research study's sample adequacy measure based on the results presented in the table.

Statistical analysts adopt the Kaiser-Meyer-Olkin (KMO) test to measure the correctness of execution factor analysis on a given sample within a study, ensuring adequate sampling. A value below 0.5 suggests an inadequate factor analysis. A value falling within the range of 0.5 to 1 means the factor analysis method is suitable for the data being assessed. Therefore, the sample size is insufficient for an exploratory factor analysis (EFA).

Table 08 presents the findings confirming that the sample adequacy is deemed satisfactory with a value of 0.633. Additionally, Bartlett's Test of Sphericity exhibits a significant result with a value of 162.863 and a significance level of 0.000, proving an identification as positive.

### Table 9

*Total Variance Explained*

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 3.506 | 87.652 | 87.652 | 3.506 | 87.652 | 87.652 |
| 2 | .474 | 11.844 | 99.496 | | | |
| 3 | .016 | .403 | 99.899 | | | |
| 4 | .004 | .101 | 100.000 | | | |

### Method of Extraction: Principal Component Analysis

The "Initial Eigenvalues" portion of Table 09 presents the Variance linked with the initial solution. In the initial solution, it is observed that just a single factor exhibits eigenvalues that surpass the value of 1. When considered collectively, the initial factors account for approximately 87.652% of the variation. This implies that the RNE CONS may possess hidden influence.
The portion of variation explained by the components retrieved before rotation is presented in the second half of the table. The cumulative variability described by the single factor in the extracted solution is 87.652%, representing an improvement of 11.844%, 0.403%, and 0.101% concerning the original solution. Consequently, around 12.348% of the explained Variance in the first solution can be attributed to latent factors intrinsic to the original variables and to unexplained variability that is not accounted for by the factor model.

## ANOVA Analysis

### Table 11

*ANOVA with Friedman's Test and Tukey's Test for Nonadditivity*

| | | | Sum of Squares | df | Mean Square | Friedman's Chi-Square | Sig |
|---|---|---|---|---|---|---|---|
| Between People | | | 7.756E+25 | 20 | 3.878E+24 | | |
| Within People | Between Items | | 1.001E+27[a] | 3 | 3.337E+26 | 51.119 | .000 |
| | Residual | Nonadditivity | 2.327E+26[b] | 1 | 2.327E+26 | 2.380E+14 | .000 |
| | | Balance | 5.769E+13 | 59 | 9.778E+11 | | |
| | | Total | 2.327E+26 | 60 | 3.878E+24 | | |
| | Total | | 1.234E+27 | 63 | 1.958E+25 | | |
| Total | | | 1.311E+27 | 83 | 1.580E+25 | | |

*Grand Mean = 1993096545641.6199*
*a. Kendall's coefficient of concordance W = .763.*
*b. Tukey's estimate of power to which observations must be raised to achieve additivity = -3.989E-7.*

The analysis results revealed a significant effect of the ANOVA test on carbon emissions. The study's findings indicate that initiatives aimed at enhancing Sustainable Development Goals (SDGs) are associated with a grand mean of 1993096545641.6199, explaining the variability observed in CO2 emissions. Additionally, this research demonstrates that the goals outlined in the (SDGs) have a positive effect on several aspects examined in the study, including GDP, TA, and RNE CONS in carbon emissions. These factors play a crucial role in achieving SDGs in China, as identified in this study. Also, it serves as a means of environmental development, which may be enhanced through Renewable Energy Consumption. This fosters the inclination to strategically manage renewable energy resources and achieve their efficacy under Sustainable Development Goals.

Moreover, the findings indicate a statistically significant correlation between renewable energy consumption and carbon emissions in the context of goals for sustainable development. The contention was made that Carbon Emissions positively impact the achievement of SDG goals. The GDP is significant in promoting economic growth while encouraging sustainability, potentially yielding beneficial outcomes in pursuing Sustainable Development Goals (SDGs). The study's findings indicated a statistically significant positive relationship between GDP and SDGs. As a component of SDG goals, economic growth has been observed to assist an expectation in carbon emissions within the context of China. Moreover, the correlation between China's use of renewable energy resources by Sustainable Development Goals (SDGs) and carbon emissions is evident.

## Conclusion

This research contributes to the preserved body of literature on sustainable development goals (SDGs) by demonstrating the significant correlation between $CO_2$ emissions and achieving SDGs in China. The research's verdicts indicate a relationship between Renewable Energy Consumption and the amount of Carbon emissions in China. The evident results specify statistical analysis that exhibits a favourable link among GDP, TA, and RNE CONS. The study's outcomes reflect that no single $CO_2$ emissions measure satisfies all the criteria outlined in the RNE CONS paradigm. It is evident that both GDP and a range of technological advancements (TAs) exhibit varying degrees of effectiveness throughout various sectors. Following a detailed investigation of China's renewable energy efforts, this study suggests a few recommendations to expedite the adoption of renewable energy sources, foster economic expansion across many sectors, and promote technological advancement. These recommendations can be defined into three distinct strategies into account.

First and foremost, it is imperative to strengthen the government's budgetary regulatory and supervisory measures. Likewise, manufacturers strive to encompass all aspects of the production process by applying advanced technologies and raising awareness amongst individuals concerning the substantial advantages these technologies offer. Lastly, empowering individuals to moderate their daily energy consumption as everybody is the minimal quantity of renewable energy preservation can influence society and the economy significantly.

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